Application No. 09/786,173

AMENDMENTS TO THE CLAIMS

A detailed listing of all claims that are, or were, in the present application, irrespective of whether the claim(s) remains under examination in the application are presented below. The claims are presented in ascending order and each includes one status identifier. Those claims not cancelled or withdrawn but amended by the current amendment utilize the following notations for amendment: 1. deleted matter is shown by strikethrough for six or more characters and double brackets for five or less characters; and 2. added matter is shown by underlining.

1. (Currently Amended) A method for estimating [[the]] movement between two numerical images, I_1 and I_2, having luminances Y_1 and Y_2, respectively, for generating for each point of coordinates x, y of the image I_2 a movement vector $\vec{d}(x,y) = (d_{x1} d_y)$ to form an image $\hat{I}_2$ that is an approximation of the image I_2 with a luminance $\hat{Y}_2(x,y) = Y_1(x - d_{x1} y - d_y)$ from the image I_1, wherein the method comprises the following steps:

(a) defining an initial model of finished elements, the model comprising a mesh having nodes that are points of the image I_2, a movement vector associated with each node of the mesh, and an interpolation formula for calculating <u>a</u> [[the]] value of the movement vector of each point of the image I_2 from [[the]] values of the movement vectors of the nodes of the mesh to which the image I_2 belongs<u>;</u>[[,]]

(b) globally optimizing the values of all the movement vectors of the initial model or a final model according to a differential method <u>to refine the initial model or the final model</u>[[,]]

(c) calculating a variation E between the image $\hat{I}_2$ and the image I_2 for each finished element or mesh;[[,]]

(d) carrying out a finer meshing on a discrete fraction of all the finished elements determined according to a criterion relating to the variation E and allocating a movement vector to each new mesh node to define the final model of finished elements;[[,]] and

(e) repeating steps (b), (c) and (d) for [[on]] the final model of finished elements obtained at the end of the preceding step (d) until a stoppage criterion is satisfied.

2. (Previously Presented) A method according to claim 1, wherein the finished elements are classified in a decreasing order of the variation E of each finished element and X first finished elements of the classification are subdivided into smaller finished elements to carry out a finer meshing on a discrete fraction of the finished elements in step (d), wherein X represents a predetermined fraction of the number of finished elements in the model.

3. (Previously Presented) A method according to claim 1, wherein to carry out a finer meshing on a discrete fraction of the finished elements in step (d), the variation E calculated in step (c) for each finished element is compared with a threshold variation that depends on a size of the finished element in question, and each of the finished elements having a variation E greater than the threshold variation is subdivided into smaller finished elements.

4. (Currently Amended) A method according to claim 1, wherein the stoppage criterion comprises a predetermined ~~predoterermined~~ number of finished elements constituting the model of finished elements defined by step (d).

5. (Previously Presented) A method according to claim 1, wherein the stoppage criterion is satisfied when the variations E of the finished elements defined by step (d) are smaller than a functional threshold variation that depends on a size of the finished elements in question.

6. (Currently Amended) A method according to claim 1, wherein for each numerical image I_1 and I_2, a set of R images I_i^r with a level of resolution r and a luminance Y_i^r is defined, with r taking the values $(0,\ldots R-1)$ and i taking the values 1 and 2, images I_1^0 and I_2^0 corresponding to the numerical images I_1 and I_2, respectively, and wherein the steps (b) to (e) are carried out for each resolution level r from the level $r = R-1$ to the level $r = 0$.

7. (Currently Amended) A method according to claim 6, wherein the sets of R images with resolution level r are obtained by filtering the images I_1 and I_2 along two directions x and y using a low-pass filter with a pulse response h_u^r, each image I_i^r [[being]] defined by the equation:

$$Y_i^r(x,y) = \sum_{u=-M}^{M} \sum_{v=-M}^{M} Y_i(x-u, y-v) h_u^r h_v^r,$$

wherein M is a natural integer.

8. (Currently Amended) A method according to claim 7, wherein the pulse response h_n^r is defined as:

$$h_n^r = \frac{s_n^r}{S}, \text{ wherein } S = \sum_{n=-M}^{M} s_n^r$$

$$s_n^r = 2B.\sin c(2\pi B_r n) = 2B\frac{\sin 2\pi B_r n}{2\pi B_r n} \text{ and}$$

$$B_r = \frac{1}{2^{r+1}},$$

and wherein B is a natural integer.

9. (Previously Presented) A method according to claim 1, wherein the movement vectors are nil vectors when the initial model is defined.

10. (Currently Amended) A method according to claim 1, wherein the variation E between the image $\hat{I}_2$ and the image I_2 for each finished element e is defined by the equation:

$$E = \sum_{(x,y)\in e} DFD^2(x,y),$$

wherein $DFD(x,y) = Y_2(x,y) - Y_1(x-d_x, y-d_y)$.

11. (Currently Amended) A method according to claim 1, wherein the interpolation formula for calculating the value of the movement vector of a point P of coordinates (x,y) in the image

I_2 belonging to a finished element e with vertices P_i, P_j and P_k with respective coordinates $(x_i, y_i), (x_j, y_j)$ and (x_k, y_k) is:

$$\vec{d}(x,y) = \sum_{I=i,j,k,} \Psi_I^e(x,y) \vec{d}(x_I, y_I),$$

wherein Ψ_I is a function of the form:

$$\begin{cases} \begin{cases} \Psi_I(x,y) = \alpha_I + \beta_I x + \gamma_I y & (x,y) \in e \\ \sum_{I=i,j,k} \Psi_I(x,y) = 1 \end{cases} \\ \Psi_I(x,y) = 0 & (x,y) \in e. \end{cases}$$

12. (Previously Presented) A method according to claim 1, wherein the differential method for optimizing the movement vectors is a Gauss-Newton method.

13. (Previously Presented) A method according to claim 12, wherein the differential method for optimizing the movement vectors is a Marquardt extension of the Gauss-Newton method.

14. (Previously Presented) A method according to claim 1, wherein a compactness constraint is imposed on each finished element when the movement vectors of the initial model of finished elements are optimized, the constraint preventing a compactness of each finished element from approaching zero.

15. (Currently Amended) A method according to claim 14, wherein the compactness constraint on a finished element e with vertices P_i, P_j, P_k and compactness C (P_i, P_j, P_k) is defined by the equation:

$$C\left(P_i + \vec{d}_{P_i}, P_j + \vec{d}_{P_j}, P_k + \vec{d}_{P_k}\right) \geq K \times C\left(P_i, P_j, P_k\right),$$

wherein $\vec{d}_{P_i}, \vec{d}_{P_j}$, and $\vec{d}_{P_k}$ represent the movement vectors of the vertices P_i, P_j, P_k during the optimization step[[,]] and K is a compactness parameter.

16. (Previously Presented) A method according to claim 14, wherein the optimization of the movement vectors under the compactness constraints on the finished elements is resolved by an increased Lagrangian technique.

17. (Previously Presented) A method according to claim 16, wherein the constraints are used in a linearized form in the increased Lagrangian technique.

18. (Previously Presented) A method according to claim 1, wherein optimizing the values of the movement vectors uses an LDL^t profile technique.

19. (Previously Presented) A method according to claim 1, wherein the meshing carried out on the discrete fraction of the finished elements in step (d) is associated with a partially quaternary tree in which each level represents a meshing level and each node represents

a triangle of the given level, and wherein a binary train describing the tree is generated for coding the images.

20. (Previously Presented) A method according to claim 19, wherein the movement vectors associated with each node of the tree are encoded differentially with respect to the movement vectors of a father node when the father node exists, and wherein the movement vectors are ordered in the binary train along a width passage of the tree.

21. (Previously Presented) A method according to claim 1, wherein the meshing carried out on the discrete fraction of the finished elements in step (d) is associated with a partially quaternary tree in which each level represents a meshing level and each node represents a triangle of the given level, and wherein the tree is generated from a binary train of encoded data describing the tree for decoding the images.

22. (Previously Presented) A method according to claim 21, wherein the encoded data relating to a given level of the tree is collectively regrouped in the binary train to generate the tree level by level as the binary train is read.

23. (Previously Presented) A method according to claim 1, wherein at least one range belongs to a group consisting of the following ranges:

- compression of sequences of images, and
- compression of data in spaces larger than 2.